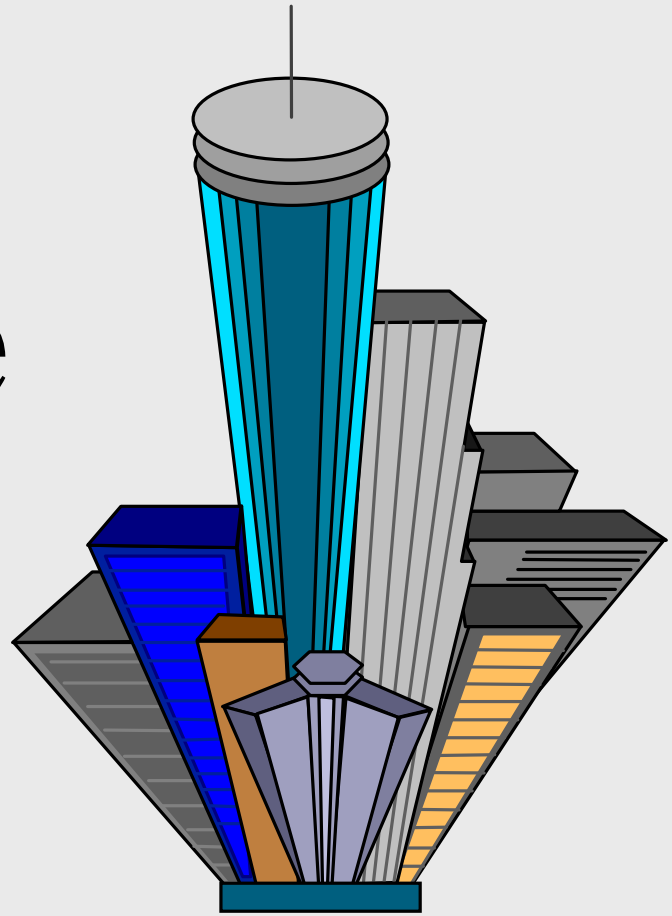
Thermal Energy Storage

A Solution for the Energy Challenges of the 21st Century



Mark D. Lindberg, PE FAFCO

ARI Thermal Energy Storage Equipment Section

Current Members

Baltimore Aircoil Company

Calmac Manufacturing Corporation

Cryogel

Dunham-Bush, Inc.

Evapco

Fafco, Inc.

Henry Vogt Machine Company

The problem...

- U.S. is 60% dependent on foreign oil
- High potential for dislocation in Middle East
- What makes more sense:
  - Build new generating capacity?

    or

  - Use existing capacity more efficiently?

What is Thermal Energy Storage?

TES is a technology which allows the generating and storing of cooling capacity at night-time in order to reduce...

- **Peak demand**
- **Energy usage**
- **Energy costs**
- **Emissions**

The chiller system is about 40% of peak demand

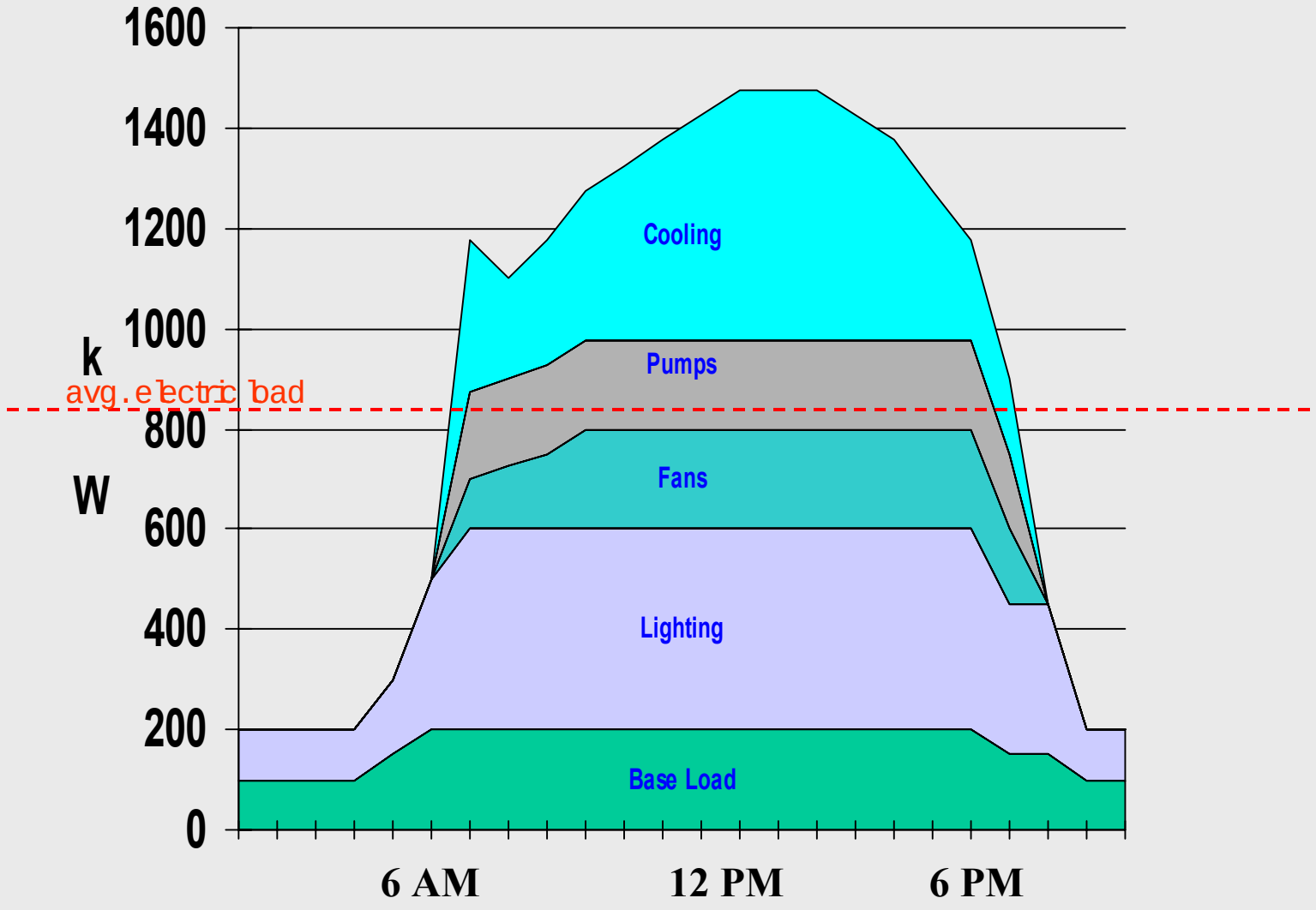
Chiller System ▪ Chiller System = 1000 W/Ton ▪ Load = 500 Ft^2 /Ton	**2 W/Ft^2**
Lighting	**1 W/Ft^2**
Miscellaneous	**2 W/Ft^2**

CHILLER SYSTEM IS ABOUT 40% OF PEAK DEMAND

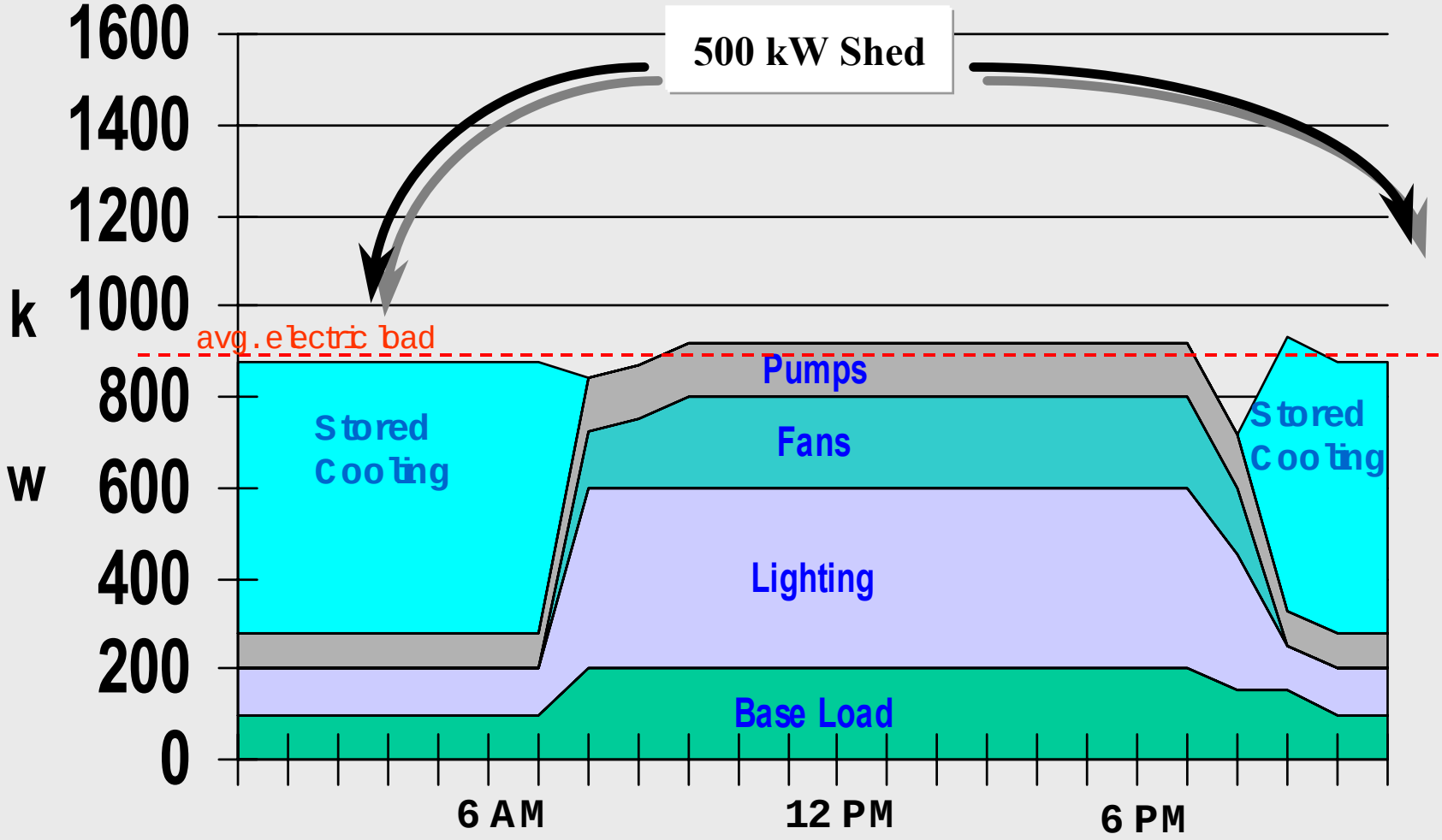
Shifting from day to night-time energy use reduces operating costs

- Daytime energy costs 4 to 5 times more than night-time energy
- A large percentage of a TES system's energy usage is at night
- TES thus reduces air conditioning kW demand by up to 40%

Conventional Cooling Profile

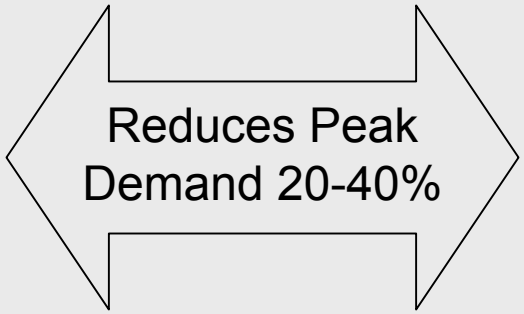


Storage Cooling Profile



Thermal Storage Benefits

Source
- Reduces source energy usage at power plant by 8-34%
- Reduces CO_2 emissions 30 to 50% vs. absorption
- Increases load factor of generation up to 25%



Site
- Reduces first cost up to 10%
- Reduces consumer's AC energy costs 10-20%
- Reduces energy usage at the building up to 14%
- Provides operational flexibility for consumer in a deregulated energy market

The Solution...

Shift existing capacity before…

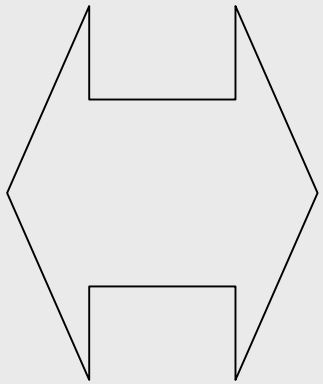
Building new capacity that…

- **Takes time**
- **Is expensive**
- **Relies on uncertain technology**
- **Pollutes**

In over 6000 installation in 35 countries around the world, TES reduces peak demand

Source Energy

8 to 30% reduction in California for each kW shifted from on to off peak[1]



Site Energy

Up to 14% reduction measured on side by side comparison[2]

[1]CEC (Report # 500-95-005) sponsored report

[2]EPA/DOE's Energy Star Building Label Program rated a building using TES 99, out of a possible 100 points, based on actual readings. This is the highest rating it has ever given. (Centex Building, Dallas, TX)

A Little History… Thermal Storage in the 1980's

- Thermal Storage became widely used in the 1980's because utilities encouraged load-shifting in order to avoid building new power plants
- Energy conservation was not a main priority
- Due to utility rebates for TES, many users did not leverage the other benefits of TES
- In the 1990's all this changed but our reputation unfortunately did not.